

DOCUMENT RESUME

ED 142 242

IR 005 159

AUTHOR Brook, R.J.
 TITLE An Experiment in Self-Paced Study.
 PUB DATE Jan 77
 NOTE 29p.
 EDRS PRICE MF-\$0.83 HC-\$2.06 Plus Postage.
 DESCRIPTORS Educational Innovation; Educational Programs;
 *Individualized Instruction; *Individualized
 Programs; *Program Descriptions; Program Development;
 Program Evaluation; Statistics
 IDENTIFIERS *Keller Plan; *Personalized Systems of Instruction

ABSTRACT

This monograph describes in detail how a Personalized System of Instruction (PSI), or Keller Plan, approach was implemented in a large statistics course at Massey University, New Zealand. Some of the strengths and weaknesses of the scheme are explored and possible extensions noted. Major areas covered are subject area (statistics), logistics, quality of learning, bonuses, and objections. Findings suggest that PSI was well received and, although considerable effort is needed to set up such a course, it provides an effective learning situation. (Author/DAG)

 * Documents acquired by ERIC include many informal unpublished *
 * materials not available from other sources. ERIC makes every effort *
 * to obtain the best copy available. Nevertheless, items of marginal *
 * reproducibility are often encountered and this affects the quality *
 * of the microfiche and hardcopy reproductions ERIC makes available *
 * via the ERIC Document Reproduction Service (EDRS). EDRS is not *
 * responsible for the quality of the original document. Reproductions *
 * supplied by EDRS are the best that can be made from the original. *

U.S. DEPARTMENT OF HEALTH,
EDUCATION & WELFARE
NATIONAL INSTITUTE OF
EDUCATION

THIS DOCUMENT HAS BEEN REPRODUCED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL NATIONAL INSTITUTE OF EDUCATION POSITION OR POLICY.

AN EXPERIMENT IN SELF-PACED STUDY

by

DR. R. J. BROOK,
MATHEMATICS DEPARTMENT,
MASSEY UNIVERSITY,
NEW ZEALAND

CONTENTS

	Page
Introduction	1
PSI in a large, introductory statistics class	2
Some logistic problems	4
Quality of learning	10
Additional bonuses	13
Possible objections	15
Additional points from the literature	19
Bibliography	24

INTRODUCTION

Self-paced instruction is not new. Many educators have grappled with the problem of encouraging students to set their own goals and to work towards them at their own pace.

Recently, a new surge of interest in self-paced instruction was generated by the work of the psychologist F.S. Keller (1968) who coined the term, "Personalized System of Instruction" or PSI. The five basic ingredients of PSI have been described by Young et al (1974) as :

- (i) Dividing the content of the course into *small meaningful units of instruction*.
- (ii) Devising *clearly written behavioural objectives* and other study materials for each unit (usually in conjunction with a text).
- (iii) Allowing the individual student to proceed through the course at his *own pace*, thus using lectures only for motivation and not as sources of critical information.
- (iv) Establishing a *unit perfection requirement* in the form of a test to be taken on a when-ready basis by the student with no penalty for unsatisfactory performance regardless of how long it takes to meet the requirement.
- (v) Using *student proctors* whose presence in acceptable numbers provides immediate marking of tests in the student's presence, immediate feedback and the personal aspect of the teaching process.

This monograph shall describe in detail how a PSI approach was implemented in a large statistics course at Massey University, New Zealand. Some of the strengths and weaknesses of the scheme will be explored and possible extensions noted. The number of articles which have appeared recently on PSI is quite extensive. In section 8, additional points are noted from the literature.

PSI, or the Keller Plan, has been well received at Massey by staff and students alike. This seems to concur with the experience of almost all who have tried it. Although considerable effort is needed to set up such a course, it provides an effective learning situation and is a viable alternative to the conventional lecture method.

PSI IN A LARGE, INTRODUCTORY STATISTICS CLASS

1 The Introductory Statistics course at Massey University shares the problems of large service courses in most institutions. These problems have been described by Young et al (1974) as "teaching the unwilling the unwanted". Students in the course are drawn from all six major disciplines in the University and often take the course only because it is required for that discipline. The students have disparate backgrounds in mathematics or any quantitative subjects and have seldom progressed far enough in their own areas to see the relevance, let alone the power, of statistics. Added to these problems is the fact that the introductory course must also cater for intending mathematics and statistics majors who would find insufficient challenge in a conventional service course, and whose presence reduces the chances for high grades for other students. A problem peculiar to Massey is the commitment to extramural tuition. The course is offered by correspondence to students throughout the country.

2 The structure of the PSI course at Massey.

The course is divided into 12 units, thus satisfying the first of Keller's five ingredients, (i) Section 1. For each unit, the student is expected to

- a. Read the study guide and the appropriate section in the textbook, (ii) Section 1.
- b. Attend the introductory lecture for that unit. As the course proceeds the lecture is often poorly attended as students may be far behind or already have passed the unit (iii).
- c. Individual tutoring is available by "proctors" or staff members (v).
- d. Each study guide contains a sample test with solutions.
- e. The study guide also contains an assignment involving numerical work. Eight of the twelve units involve the use of a computer program MINITAB, an easily learnt and powerful computer package.
- f. When the assignment is completed, the student may attempt a test on the unit. A score of 90% must be attained (iv). The test is marked by a proctor, or staff member, in the presence of the student. If he does not pass, the student may attempt another version of the unit test at a later testing session.

To pass the course, only the first 9 units must be passed.

Two important changes have been made to the course in 1976. In the first year of operation, 1975, an 80% pass was required on each unit test but a sample test with solutions was not included. The sample test gives more direction to the students' learning thus providing the opportunity to revise points that have not been grasped.

3 The PSI approach as implemented at Massey has the following main ingredients :

- a. The course is divided into small well-defined units.
- b. Study guides clarify points in the textbook and give direction on what is to be learnt. Sample tests and assignments ensure that students consolidate their understanding.
- c. Each unit is known well before moving on to the next one as a 90% pass is required.
- d. Students have flexibility in timetabling this course. The testing room is open, on average, 9 hours per week. Units 4, 7, 9 must be completed by the end of terms 1, 2 and 3, respectively, but faster students may pass units 7, 9, 12 at the end of these terms.
- e. Lectures are not the focal point of the course and, in fact, become more poorly attended as the year progresses. The main reason is that students are at different points in the course so that lectures are often either too far advanced or too far behind.
- f. The grade received in the course is very dependent on the amount of work done. The student is virtually assured of a pass by successfully completing the first 9 tests. A higher grade than C will almost certainly be obtained if the 12 unit tests are passed.
- g. Perhaps the most important aspect of the course at Massey is that there is considerable personal contact between students and staff and proctors in tutorials but especially in the marking of tests which becomes an important learning experience.

4 The number of students in the statistics course.

In 1975 the initial enrolments for the course was 370. In 1976 the enrolments increased to 526 with an additional 135 extramural, or correspondence, students. Such a large enrolment poses problems for any method of instruction. The PSI approach appears well-suited to a large class like this.

SOME LOGISTIC PROBLEMS

1. The testing room.

A small class presents few problems in implementing a PSI approach. The first difficulty with a large class is to obtain a suitable testing room. At Massey, a single room is used for 9 hours a week to cater for 500 students. The lay-out of this room is shown below.

Although the room is large enough (it can seat 40 to 50 students) and provides a somewhat informal atmosphere as desks and chairs can be moved and rearranged, it is inadequate for the different and conflicting demands. For testing purposes, the room needs to be quiet, but for the marking of the tests and the correcting of assignments, discussion is encouraged between proctors and students. One solution is to have the testing room open for longer periods. This reduces problems such as high noise level, long waiting times to have tests corrected and mistakes in keeping records. Perhaps, the ideal situation would be as in McKean (1973) where interconnecting rooms are used with a staff member at the "hub" to be available if difficulties arise, to clarify points in tests or assignments or to decide whether a borderline student should pass.

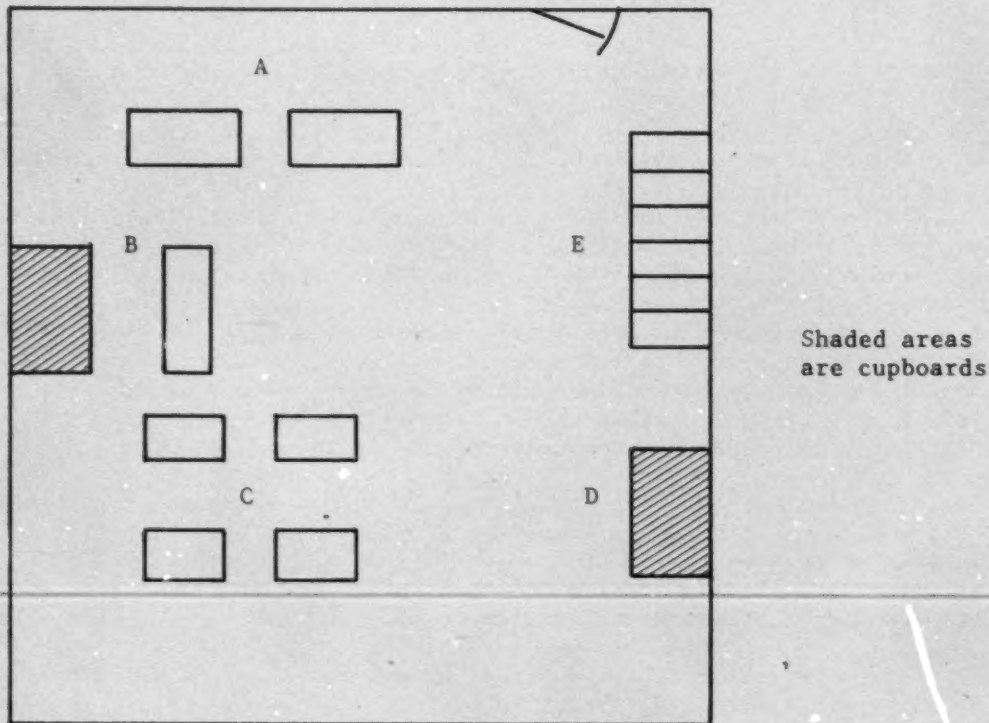


Figure 3.1 Layout of testing room.

Subdivision of the testing room into 5 main areas of activity :

- Area A : Proctors check assignments, hand out printed solutions, and mark tests.
- Area B : Unit tests given out and date stamped records kept on the computer record cards.
- Area C : Students sit the tests and present them for marking when complete.
- Area D : Study guides and computer cards are stored in the cupboard. During testing sessions, this material is placed on tables for the students to help themselves. Study guides are labelled with computer printed name labels, which have been found to reduce waste.

Area E : Computer programs are submitted by placing in trays.
The printouts are returned to the pigeon holes.

2 The checking of assignments.

Although the assignments do not count towards the final marks in the course, they do play a vital role in consolidating ideas in the unit and broadening the student's knowledge. Whereas the unit tests and mid-year and final exams require only short answers, the assignments require the students to work through longer problems. For some of these the student supplies his own data or uses data generated by the computer. Ideally, these assignments should be marked very carefully. This is not always possible under the Massey scheme due to the difficulty in ensuring proctors particularly in rush periods.

When a student enters the testing room, his assignment is checked by a proctor as thoroughly as possible but constrained by the other demands on the proctor at that time. If the assignment is deemed satisfactory, it is stamped with a date stamp and the student is given printed model solutions to the assignment.

There are disadvantages in handing out model solutions when students are progressing through a course at their own rate. There is a strong temptation to obtain the printed solutions from a friend and use them instead of working the problems by oneself. On the other hand, the assignments are often quite lengthy and the proctor does not have time to accurately check each part of it. The printed solutions allow the student to check his own work, or to see other approaches to the problems.

In future, space will be available in the study guides for the student to complete his assignment. In this way, guidance can be given as to the format of tables etc. and will allow quicker correction by the proctors.

3 The handing out and marking of tests.

Once his assignment is stamped, the student proceeds to the test area and is given a version, selected at random, of the appropriate test. The particular version is noted on that student's record card for that unit as explained below. If the student is repeating a test, the student's proctor, or staff member, can easily see from his record card

the tests which have been attempted and, consequently, can ensure that the student is given a different version.

After sitting the test, the student writes his name on the test, has it marked by the proctor who circles pass or fail on the test.

4. Records.

A major difficulty in a self-paced course is keeping track of the progress of students. The system of record cards is easy to maintain, is relatively foolproof and allows a quick check on those who have passed, or not yet attempted, a certain unit. For each of the twelve units, a blank card is used for each student in the class. The card is, in fact, a computer card which has the added advantage of allowing a computer print-out to be obtained of the state of the class.

A typical record card is shown in Figure 3.2.

STAN DEVIATION	UNIT 3	1	2	3	4
			F	F	P
			13 4/76	11/4/76	17/4/76

Figure 3.2 A Computer Record Card

The information along the top of the card is key punched. The date is stamped when the student presents himself for a test. During the testing sessions, a proctor in charge of records collects the corrected tests from the other proctors and writes F or P in the appropriate space. The above card indicates that Mr Deviation attempted version 3 of unit 3 on April 11 and failed. He also failed version 2 on April 13, but passed version 4 on April 17.

Once Mr Deviation has passed unit 3, the card is placed aside and at the end of the week with the other cards the "F, F and P" are key punched in the appropriate places. The card then has key punched all the relevant details, except dates, on it, namely

STAN DEVIATION	UNIT 3	1	2F	3F	4P
----------------	--------	---	----	----	----

A simple program enables a regular printout to be obtained showing, for each unit, an alphabetical list of the students who have passed the unit along with some useful statistics, for example, the number of attempts at the unit taken by each student, the percentage of the class who passed at the first attempt, and the total number of attempts at that unit.

Cards for those who have not attempted (say) unit 3 are kept in alphabetical order, and these are kept separate from those who have attempted but failed unit 3. When a student presents himself for a test, his record card can be found extremely quickly by flicking through the appropriate deck of cards.

5 Class printout.

Each week, the computer cards of those who have passed tests are fed into the computer to update the data file showing the progress of the class. A weekly printout is then obtained as in the hypothetical example below.

INTRODUCTORY STATISTICS

STATE OF THE CLASS AT 17 - 4 - 76

	UNIT (number of attempts in parenthesis)						
	1	2	3	4	5	6	7
J.P. AARON	P(2)	P(1)	P(3)				
J.A. ADAMS	P(4)						
P.J. AINSWORTH	P(1)	P(1)	P(1)	P(2)			
...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...
P.A. WRIGHT	P(2)	P(2)	P(1)				
Z.Y. ZULAF	P(2)	P(1)					

STATISTICS AS AT 17-4-76

UNIT	1	2	3	4	5	6	7
No. who have passed	382	171	63	18	4		
No. of tests sat	532	260	97	26	5		
% pass at 1st attempt	75	80	72	78	75		

6. Procrastinators.

Some studies have suggested that problems occur in a PSI scheme when students fall behind, or procrastinate. This has not really been a major problem at Massey although deadlines have been set for the end of each term. A few weeks before each deadline, those who have fallen behind have been sent letters to remind them of these deadlines. Admittedly, there are a number of students who leave some tests until the last moment so that the testing room is often crowded in the last week of each term.

This seems to be an annoyance which staff must endure, for if the course is to be really self-paced then students must be given the freedom to procrastinate. Some studies in the United States have assigned students to particular proctors, whose job it is to chase up students who fall behind. For a course at secondary school level this may be acceptable, but at the tertiary level it could be argued that part of the educational process is learning to organize one's time and effort.

QUALITY OF LEARNING

1 The views expressed here are admittedly subjective and biased. Arguments could equally well be marshalled against the Keller approach. Actually, some claims of objective proof for the superiority of PSI could be questioned. For example, Born and David (1974) state that "The superior performance on midterm and final examinations by students in the PSI section is consistent with previous reports". In the same paper they point out that, "... the combination of the PSI requirement that students demonstrate mastery of small units of course material, and the limited number of opportunities for test taking, tended to regularize study behaviour ...". The implication could be drawn that, under this PSI scheme, students were forced to work more regularly than they would normally do. It is not surprising that they scored higher on exams than those under conventional schemes.

Certain statistics are presented below which suggest that students felt that they benefitted from the Massey PSI course.

2 Attitude of students.

Each year, questionnaires have been given out to the students. Unfortunately, the response rate is not high, a fact which could produce biased results. This questionnaire was administered during one week in the second term when it was expected that the sample of students who sat tests was a reasonable cross-section of the whole class. For the question, "Do you prefer the approach of this course to the conventional lecture approach?", the response was

	Yes	No	Others
1975	224	5	8
1976	190	14	4

In 1976, another question elicited the responses in parentheses. "Since taking this course my interest in statistics has decreased (11), increased (105), remained about the same (92)".

In the ante calendar produced by students for incoming students this year, 1976, the comment was made, "Of all courses evaluated by our questionnaire, we would have no hesitation in awarding the A++ of the Social Sciences to the following paper - Introductory Statistics".

3 Continuing attitudes in other courses.

The number of students in the main second year paper have doubled this year from 25 to 50, although the other mathematics papers have shown little increase. Furthermore, withdrawals from this paper have been small so that students were not falsely attracted to statistics nor have they been deterred by a conventional approach at second year.

Favourable comments have been received from other departments, including suggestions that their students have a more positive approach to quantitative methods as a result of the PSI course.

4 Aspects of the course preferred by students.

Of the 208 in 1976 who replied to the questionnaire, the most frequent comments to "What do you like most about the course" were

"Working at my own pace"	(127)
"Ability to resit tests, guaranteed pass"	(29)
"Continuous assessment"	(29)
"Personal attention given by staff"	(7)
No response	(8)

"What do you like least about this course?" elicited the response

"Lectures out of phase or not helpful"	(15)
"High pass rate of unit tests"	(14)
"Deadlines too rigid"	(12)
"Assignments too long, too hard or unrelated to tests"	(10)
No response	(64)

"Suggest one way in which this course could be improved" brought forth

"More testing sessions"	(16)
"Lower pass rate in unit tests"	(14)
"Improve study guides - content, more examples, greater availability"	(13)
"More lectures"	(12)
No response	(99)

5 The amount of understanding gained by students.

Some other responses to this year's questionnaire may be of interest.

- a. Compared with what I expected, the difficulty I have experienced with Statistics is more (49), less (63), about the same (104).
- b. Compared with what I expected the understanding I have gained about Statistics is more (128), less (13), about the same (66).
- c. Compared to other first year courses at Massey, the amount of work required by this course is more (53), less (35), about the same (116).
- d. Compared to the conventional lecture method the amount of understanding you get with the approach in this course is more (125), less (17), about the same (59).

From these responses, it seems that students felt that the amount of work involved and the difficulty of the material was about the level they expected. Presumably, the PSI approach was similar in these respects to the better known conventional approaches. As far as understanding the material, however, the students felt they had succeeded with PSI more than they had anticipated.

6 Experience of extramural students.

Extramural students are usually more conscientious and mature than internal students. The extramural students in the Introductory Statistics followed the same study guides and textbook as the internal students, completing the assignments but not sitting the unit tests. In the compulsory August vacation course they were given the opportunity of sitting up to 5 unit tests and receiving up to 5 marks for each test. It was expected that most of these students would have received consistently high marks, but surprisingly many performed rather poorly, at least at first. This suggests that without the requirement of passing a test at a high level their learning was not concise and accurate. Even though they had access to a sample test with solutions for each unit, they had not trained themselves to learn the material sufficiently thoroughly to pass at a high level. Quite possibly, the discipline of having to pass tests at a 90% level encourages good learning habits.

ADDITIONAL BONUSES

The PSI course at Massey has given a number of side bonuses to the staff, proctors and the students. Some of these bonuses could arise, however, from less drastic modifications to a conventional teaching program than a program such as the PSI.

1 For the staff.

The most noticeable and gratifying benefit to the staff was the positive approach of the students. Admittedly for the first month or so the students were somewhat reserved, or even suspicious, about this new program. After passing at least one of the unit tests, most students seemed to be assured that there were no hidden tricks and became confident that they could pass the course with sustained effort.

The unit tests provide a continual source of feedback to the staff. As the tests are marked in the presence of the students who can be challenged to orally defend their answers, the staff appreciate the difficulties experienced by the students and are made aware of ambiguities in questions on the test or statements in the study guides or lectures.

The Keller method also brings home to the instructor the need to clarify, if only to himself, the objectives of each segment of the course. In a structured course like statistics, it was not felt necessary to include in study guides the "clearly written behavioural objectives" mentioned in the introduction.

2 For the proctors.

The proctors at Massey either give personal tutorial help or mark the unit tests. Both of these activities require the proctors to have a wide understanding of the course.

For the first year, 1975, of operation, third and fourth year students were hired to mark the unit tests. In 1976, both tutoring and marking were required of the proctors. In keeping with procedures in some PSI experiments in the USA, second year students were employed who had passed the course in the previous year. They had already demonstrated a detailed knowledge of the course. This knowledge is sharpened by the response of explaining sections of the book and study guides in the tutorial sessions, and by justifying answers to tests in the marking situation.

As students progress through the course at their own rate, a proctor may be called on to mark tests on unit one or even up to unit six. Again, this puts pressure on the proctors to know the whole course well and to continually review many units of the course. Maybe, all statistics majors should be required to assist in this course. The basic methods of statistics would be thoroughly known!

Furthermore, the proctors appear to appreciate the opportunity of working in close contact with the staff. Having the previous year's students as proctors allows a useful dialogue between them and staff members. As they have an inside knowledge of the course, they are quick to make suggestions for the improvement of tests and assignments.

3 For the student.

At first it may seem a contradiction that in a self-paced course students have more contact with staff than in the more conventional lecture course. Yet, this is in fact so and the reason is not hard to find. In tutorials and testing there is a one to one relationship between student, on the one hand, and a staff member or proctor, on the other. In particular, those students who find difficulty with the material and who often need more than one attempt at a unit test become well-known to the staff. The one student who sat a total of 30 tests in order to pass 9 units was no stranger to staff and proctors. Conversely, the staff were well-known to him.

In a large class and with many calls on their time, staff members will not be able to know all students. The important point is that students have the opportunity of contact with staff members. It could also be mentioned that in the testing sessions, there are additional brief contacts made in the checking of assignments and then the selection of a version of the appropriate test. In contrast, those students who habitually sit near the back of a large lecture theatre may have difficulty even recognizing their lecturer at closer range. This comment may sound specious and frivolous, but colleagues confirm that this situation does arise.

From the students' point of view, however, an attractive feature of PSI is the flexibility. The only deadlines are that unit 4 must be completed by the end of the first term (and faster students may complete unit 6 or beyond); at the end of the second term unit 7 is required (unit 12 or the whole course can be completed); unit 9 must be passed before the end of the year.

The other feature which the students liked was the assurance that they would pass the course by successfully completing sufficient unit tests. Fear of failure in exams can have a debilitating effect particularly on weaker students. With the assurance of success, or the option of withdrawing from the course, many weaker students found to their surprise that they could cope with this mathematical subject.

POSSIBLE OBJECTIONS

1 Students are processed mechanically.

To run a PSI course with a large class involves considerable organization to overcome the many logistic problems. It could be felt that students, and their feelings, would be relegated to a lower place than the efficient running of the course. Evidence suggests that this is not so, and, in fact, there is more personal interaction than in a conventional course. Tutorials, marking of assignments, issuing of tests, marking of tests, and, of lesser importance, lectures involve the student in contact with proctors and staff members.

The urge to automation is strong, but, if it tends to erode personal contact with students, it should probably be rejected. Proponents of computer assisted instruction would perhaps advocate the use of remote terminals to a computer. A random test generator could be incorporated so that the students would communicate directly with the computer. However, this set-up would erode the personal aspect of PSI. If the proctors are enthusiastic, their handing out a test with a friendly comment could be a positive motivation to the students.

2 It is too easy to pass in a PSI course.

In the first year of the course, the pass rate was 95%, which was much higher than in other first year papers. All those who persevered with the course and completed the test for unit 9 received a passing grade. This caused some adverse reaction in certain quarters and the suggestion was made that the course was too easy.

In 1975, only 4% of the students who enrolled for the course withdrew during the year. This was unexpected as overseas experience had suggested a higher withdrawal rate was more common. Newman et al (1974) state that, "In relation to traditionally taught courses, several authors have reported increases in the number of students to withdraw from PSI courses".

It appears, at this stage, that the withdrawal rate in 1976 will be higher than last year so that the pass rate could be lower. The withdrawal rate was probably affected this year by the staff not being as zealous in warning procrastinators of approaching deadlines, and to the disenchantment of some students who possibly enrolled for the course expecting it to be an easy option.

On the matter of pass rates, the distinction should be made between the assurance given to students that they would pass the course if they completed successfully enough unit tests, and the amount of work required in the course. From questionnaire results, it is clear that students felt that the amount of work in the PSI course was at least as much as in a lecture course.

3 The Keller Plan uses too many resources.

Prior to setting up a Keller-type course, it was assumed that it would be labour intensive and that more student markers would be needed than under a more conventional scheme. As it has turned out, there is little difference between the statistics course and the three first year mathematics courses. The 1976 enrolment figures are

	Internal	Extramural	Total	markers	students per marker
Statistics	526	135	661	11	60
Mathematics	384	177	561	9	62

The term "marker" is really an administrative term as it refers to 6 hours of marking per week. In fact, there were 18 proctors who worked for differing numbers of hours each week.

As far as staff loads are concerned, the mathematics courses are assumed to be twice as onerous as the statistics course. Admittedly there are three mathematics papers which differ partly in content and partly in their level of difficulty. To some extent the statistics course has tackled the same problem of differences in students' background and ability by allowing flexibility in goals, as students may aim to pass 9, 10, 11 or 12 units, and flexibility in the speed of progress through the course.

For a class of 500 internal students, the actual contact hours per fortnight of staff with students would be roughly as follows:

	<u>Keller Plan</u>	<u>Conventional</u>
Lectures	2	8
Tutorials	6	20
Testing	18	-

Under the conventional teaching scheme all the statistics staff and some senior students would share the tutorials.

Under the Keller Plan, staff and students share in the tutorials. The statistics staff also share in supervising the testing sessions. Perhaps, this is not a completely fair comparison as the staff responsible for the Keller course need to give general oversight to keep the machinery well oiled.

The greatest difference in the two teaching methods has been the amount of printed material. At a rough count, the number of pages of printed material for study guides, solutions, tests etc. was 420 in 1976. It should be pointed out that all the extramural courses at Massey have printed study guides, some of these being much briefer than the statistics ones.

4 "It is easy to miss the forest for the trees".

With PSI the course is segmented into well-defined units. There is a danger, then, that the immediate goal of passing the next unit test will dominate the student's thinking. There could be, then, some truth in this objection that the trees of the unit tests are subsequently brought into focus but the overall forest remains unclear.

The midyear and final exams do provide a motivation for studying a number of chapters from the textbook leading, hopefully, to a more global picture of the course. By the nature of the subject matter, the unit tests do follow on from one another and hence it is easy to include questions on a test of ideas introduced in an earlier unit. In fact, a deliberate attempt has been made to do this.

It should not be forgotten that assignments play a large part in the learning process. Whereas the questions on the tests can only probe a single step in a process, the assignments offer opportunities to work through the whole process in (say) the testing of an hypothesis. The forest may become visible.

- 5 The Keller Plan teaches students to pass tests and, only secondarily, the subject matter.

It must be admitted that testing forms a large part of the course. Great emphasis must be placed on the quality of questions in the tests. To construct meaningful questions is no easy task for, on the one hand, students should be given sufficient direction in the study guides to know what is required, yet, on the other hand, the questions should demand real mental effort.

Again, the complementary role played by assignments in this course should be noted. This is in keeping with most approaches in University papers. The student is expected to acquire a greater range of skills and understanding that can be tested in an examination. In other courses, discussion groups, films, projects, etc. could be used in a PSI scheme.

- 6 All students must pass through the same channel.

Programmed learning and computer assisted instruction allow for differing abilities and backgrounds of students by providing different paths through the subject matter. The PSI approach seems to be more narrow and limited. Students do have flexibility in their speed of progress and the amount of material they cover but do not have the flexibility of choosing different paths.

In 1976, small steps were taken to include some of the strengths of programmed learning into the course. For some assignments, students must supply their own data for a computer program. Some optional questions have been included in other assignments. Clearly, much more could be attempted in this direction, particularly as some students have strong backgrounds in mathematics and would prefer problems requiring a more rigorous approach. Other students have little interest in statistics per se but see it as a useful, or necessary, tool for their chosen major field. Such students would prefer more applied problems.

ADDITIONAL POINTS FROM THE LITERATURE

1 How new is personalized instruction?

Mickelson(1972) pointed out that the basic approaches to individualization began in the United States with Preston Search and John Dewey. He noted that, "Search was concerned with finding a way of presenting a fixed body of subject matter to the child to be mastered at his own speed. Dewey, on the other hand, sought to develop a truly child centered curriculum." It would seem that PSI follows more in the tradition of Search. At Massey, some attempt, as explained in section 6.6, has been made to allow the student to pursue optional or individual problems. No doubt, more could be attempted in this area.

Gibb (1970), along with Mickelson, noted other experiments in individualized instruction including the Winnetka and Dalton Plans and the project and contract methods.

2 Recent approaches to individualized instruction.

Mortlock (1973) referred to large scale projects in mathematics which are in operation in different parts of the world, including the Individual Mathematics Programme of Australia. He warned that, "Despite the number of projects concerned with individualizing instruction, it is apparent that to do so effectively is an extremely difficult and complex task involving economic, managerial and instructional problems".

Despite the difficulties involved, many teachers such as Noddings (1969) have set up their own programs. Farrell (1974) tried to find some common experience amongst teachers who were inclined to set up their own programs but could find no correlation between such an inclination and other variables such as teaching experience, department and number of publications.

3 Alternatives to the lecture method.

The conventional method of teaching, relying heavily on lectures, has been criticized in many quarters. Moo-Young (1972) stated that, "Educators in general are disturbed by the conventional lecture method of instruction, which educational psychologists have now recognized to be ineffective in terms of the learning process, notably for subjects requiring higher cognitive skills."

Some proponents of computer-assisted instruction view this as the logical replacement of the lecture method. Suppes and Jerman (1970) made the bold statements, "Leaders in education and industry cite several educational requirements that make computer-assisted instruction (CAI) inevitable ... The question of whether CAI will play an increasing role in education is no longer debated".

Other educators are more hesitant about the importance of the role that technology should play in the educational process. Many individualized learning systems include instructional material such as tapes and audiovisual equipment. Wilson (1974) suggested a theoretical model to systematically integrate this material into a learning system.

The current surge of interest in self instruction was rather flippantly referred to by Schoen (1974) as a "missionary movement". He prophesized that in future, "the new battle lines will probably be criterion referenced evaluation, more precise learner and learning analysis and adaptive teaching strategies as a function of diagnostic-prescription routines".

One of the important strengths of PSI is that, while allowing students to learn at their own pace, dialogue is retained between them and the staff.

4 Appropriate subject areas for PSI.

The movement towards individualized instruction received its greatest boost by an article by Keller (1968) who formulated PSI on behavioural principles. This particular article has often been cited by other authors, Science Citations listing 9 references in 1975.

PSI courses have been developed in many areas, including psychology - Fanner et al (1972), Johnston and Pennypacker (1971); chemistry - Shotter et al (1974); chemical engineering - Moo-Young (1972); mechanical engineering - Gessner (1974); statistics - Wagner and Motazed (1972); mathematics - Young et al (1974); special education - Gaynor and Wolking (1974). McKean et al (1973) quoted other experiments in such diverse subjects as music, english, physics and computer science.

Some teachers concede that the PSI approach is useful for the training of skills but feel that it would be inappropriate for their subject area. This may well be true and it would be foolhardy to view PSI as a universal educational panacea. It may be, though, that their views of the possibilities of PSI are limited. It can be a beneficial adjunct to other

forms of instruction. Keller (1968) noted that "As for the teaching-training distinction, one needs only to note that it is always the instructor who decides what is to be taught, and to what degree, thus determining whether he will be called a trainer or a teacher. The method he uses, the basic reinforcement contingencies he employs, may be turned to either purpose".

5 Mastery criteria.

Keller (1968) defined mastery as perfect performance, 100% correct, on unit tests. Wagner and Motazed (1972) demanded 100% mastery. Young et al (1974) administered closed book tests. The student's mark was recorded and this helped determine the final grade in the paper. The student could repeat a test to improve his mark. However, the student was then required to sit an open book test. "It is ultimately required that the student present to a proctor a perfect set of well-organized solutions to the problems ... Thus the open-book quiz provides the unit perfection requirement of PSI." This experiment appears unusual as the mastery criterion is not on the closed book test but an open book one which could be discussed with the proctors and, hence, appears similar to the unit assignments at Massey.

Semb (1974) divided his class and required 100% mastery from some of the students, but only 60% from the others. He found that, "a low mastery criterion produces inferior test performance when compared to a high criterion".

In another experiment in England, which was only a qualified success, Shotter et al (1974) only required 60% mastery. Further, they stated they intended to reduce this to 50% in the future. This seems out of step with a Keller plan and probably reflects a different tradition in testing in the United Kingdom from North America.

6 Proctors

One approach is to assign students to specific proctors. Gaynor (1975) stated that "In the Keller model, a high level of interpersonal relationship is fostered because proctors work with the same seven or eight students through all units of the course." Johnston and Pennypacker (1971) used, "more advanced students (called student assistants or manager) who were "experts" in the subject matter of the course. This manager-student relationship was defined in performance sessions which served both an evaluative and a teaching function". This procedure does lead to difficulties, however, as Gaynor (1975) pointed out, "If proctors

are held responsible for the performance of specific students, the problem of scheduling becomes more acute self-pacing becomes proctor-pacing".

In most PSI courses, as in Farmer et al (1972) the proctors are students who have taken the course in previous years, or semesters, and had shown mastery over the material. Others, such as Gaynor and Wolking (1974), used currently enrolled student proctors. This approach has some advantages in that the proctors have a greater motivation to be familiar with the course content.

Different courses use proctors in different ways. These include some, or all, of the six broad categories of service noted by Gaynor (1975) - scheduling of meetings with students, testing, giving feedback on the students' responses, tutoring, recording of results and reinforcing, or encouraging, students.

7 The proctors at Massey were not given special training.

In 1975, the staff met fortnightly with the proctors to discuss solutions to the unit tests and administrative policies for the course. These meetings were also a means by which the staff tried to help the proctors develop a positive and enthusiastic approach to the course. Some informal discussions on how proctors should mark the tests occurred in these sessions, but there were no formal training sessions for them. During 1976, as the proctors had successfully mastered the course in 1975, staff and proctors met less regularly. Solutions to unit tests were handed to the proctors informally during the slack periods of the testing sessions.

8 Dividing courses into modules.

Urquhart (1971) explained a scheme for dividing a statistics course into segments which could be attempted by students, subject to some constraints, in the semester and in the order they desired. The first segment was compulsory but, after that, students could choose which segments to study. Urquhart commented that "This allows students to study those topics which seem appropriate to their discipline at one point in time while still allowing them to come back at some later time to pick up specific topics that they have found they needed".

Although Urquhart did not use a Keller approach, it is easy to imagine that PSI could facilitate a division of a course into well-defined modules. A step in this direction was taken at Massey in 1976. Due to an unexpected staff shortage in the Technology Faculty, their second year

students were required to pass units 10, 11 and 12 if they had not already done so in 1975. This suggestion opens up interesting possibilities for co-operation between departments, particularly in the area of statistics. Psychology students often need a detailed knowledge of factorial experiments; econometrics students are more concerned with regression; educationalists may use factor analysis. With a segmented course, students could choose the particular area in which they are interested. This becomes even more important at the graduate level when a student, who has a basic knowledge of statistics, desires to use a more sophisticated technique for his thesis.

9 Some words of caution.

The literature on PSI is full of praise for the method and the response to it by students. A cautionary note may be appropriate at this point. The teacher who desires to set up such a course must realise that he is committing himself to a considerable amount of work. Study guides and tests need to be prepared, proctors obtained, scheduled and trained. The logistics of testing facilities and the keeping of records need to be organized. The first time the course is operated, unforeseen difficulties arise and must be solved. From such an experience, Craver (1974) wrote, "Hopefully, the disappointment and discouragement are temporary ... the visions of a self-paced course obtained from laudatory papers are too often visions that can be attained only after two or three semesters".

From his experience, Gessner (1974) said, "We did not run far. It soon became apparent that too much class time was being spent on taking tests - time which could have been better used in discussion". It is interesting to note, however, that even though they were somewhat discouraged by their first attempt at PSI, they recognized the strengths of the method and planned to continue using it with some modifications.

Schoen (1974), while recognizing the criticism that the objectives of a PSI approach are often too narrow, suggested that "a more careful writing of objectives would eliminate the existing shortcomings of the individualized programs".

To these findings can be added the experience at Massey that PSI is a viable alternative to the lecture method even for a large class, but it needs to be modified to suit the needs of the individual teacher, his class, his subject area and his objectives for the course of study.

BIBLIOGRAPHY

- Born, D.G. and Davis, M.L. (1974). Amount of distribution of study in a personalized instruction course and in a lecture course. *Journal of Applied Behavior Analysis*, 7 (3), 365-375.
- Craver, W.L. (1974). A realistic appraisal of first efforts at self-paced instruction. *Engineering Education*, 64 (6), 448-450.
- Dahlke, R.M. (1974). Determining the best predictors of success and of time of completion or dropout in an individualized course in arithmetic at a community college. *Journal for Research in Mathematics Education*, 5 (4), 213-223.
- Fachnie, J.D. and Schillace, R. (1973). Attitudinal effects as a function of undergraduate statistics course design: personalized (self-directed) vs. traditional. *Higher Education*, 2, 73-80.
- Farrell, B. (1974). Attitudes toward methods of individualized instruction in higher education. *Improving Human Performance Quarterly*, 3, 169-174.
- Farmer, J., Lachter, G.D., Blaustein, J.J., and Cole, B.K. (1972). The role of proctoring in personalized instruction. *Journal of Applied Behavior Analysis*, 5 (4), 401-404.
- Gaynor, J.F. (1975). Analysis of the proctoring variable in PSI courses. *Educational Technology*, 15 (3), 30-35.
- Gaynor, J.F. and Wolking, W.D. (1974). The effectiveness of currently enrolled student proctors in an undergraduate special education course. *Journal of Applied Behavior Analysis*, 7 (2), 263-269.
- Gessner, F.B. (1974). An experiment in modified self-paced learning. *Engineering Education*, 64 (5), 368-371.
- Gibb, E.G. (1970). Through the years: Individualizing instruction in mathematics. *Arithmetic Teacher*, 17 (5), 396-402.
- Harris, M.B. and Liquori, R.A. (1974). Some effects of a personalized system of instruction in teaching college mathematics. *Journal of Educational Research*, 68 (2), 62-66.

- Johnson, P.C. (1974). Individualized teaching and learning. *Science Teacher*, 41 (6), 20-22.
- Johnston, J.M. and Pennypacker, H.S. (1971). A behavioral approach to college teaching. *American Psychologist*, 26, 219-244.
- Keller, F.S. (1968). Goodbye, teacher ... *Journal of Applied Behavior Analysis*, 1, 79-89.
- Malott, R.W. and Svinicki, J.G. (1969). Contingency management in an introductory psychology course for one thousand students. *The Psychological Record*, 19, 545-556.
- McCollom, K.A. (1974). Self-paced learning and student motivation. *Engineering Education*, 64 (6), 427-429.
- McKean, H.E., Young, D.L., and Newman, F.L. (1973). A tale of three campuses: A PSI model for an undergraduate statistics service course. Technical Report No.47, Department of Statistics, University of Kentucky.
- McMichael, J.S. and Corey, J.R. (1969). Contingency management in an introductory course produces better learning. *Journal of Applied Behavior Analysis*, 2 (2), 79-83.
- Mickelson, J.M. (1972). Personalized instruction: How new is it? *Education Digest*, 38 (3), 38-40.
- Moo-Young, M. (1973). Experience with guided self study. *Engineering Education*, 63 (1), 27-29.
- Mortlock, R.S. (1973). Individualizing instruction in mathematics: some characteristics and an example. *The Australian Mathematics Teacher*, 29 (2), 95-103.
- Newman, F.L., Ball, S.E., Young, D.L., Smith, C.C., and Purtle, R.B. (1974). Initial attitude differences among successful, procrastinating, and "withdrawn-from-course" students in a personalized system of statistics instruction. *Journal for Research in Mathematics Education*, 5 (2), 105-113.
- Noddings, N.L. (1969). Providing for individual rates of learning in mathematics. *Mathematics Teacher*, 62 (7), 543-545.

- Powers, R.B. and Edwards, K.A. (1974). Performance in a self-paced course. *The Journal of Experimental Education*, 42 (4), 60-64.
- Schoen, H.L. (1974). A plan to combine individualized instruction with the lecture method. *Mathematics Teacher*, 67 (7), 647-657.
- Semb, G. (1974). The effects of mastery criteria and assignment length on college student test performance. *Journal of Applied Behavior Analysis*, 7 (1), 61-69.
- Sheppard, W.C. and MacDermott, H.G. (1970). Design and evaluation of a programmed course in introductory psychology. *Journal of Applied Behavior Analysis*, 3 (1), 5-11.
- Shotter, R.G., Stride, J.D., and Williams, R.L. (1974). Trial of a self-paced study course. *Chemistry in Britain*, 10, 295-298.
- Schwen, T.M. (1970). Self instruction. *Audiovisual Instruction*, 15 (6), 110.
- Suppes, P. and Jerman, M. (1970). Computer assisted instruction. *National Association of Secondary School Principals Bulletin*, 54 (343), 27-40.
- Urquhart, N.S. (1971). Segmenting service courses. Technical Report Series No.21, Statistical Laboratory, New Mexico State University.
- Wagner, G.R. and Motazed, B. (1972). The proctorial system of instruction combined with computer pedagogy for teaching applied statistics. *The American Statistician*, 27 (3), 36-39.
- Wilson, T.C. (1974). A model for the systematic integration of instructional materials into individualized learning systems. *Audiovisual Instruction*, 19 (5), 7-10.
- Young, D.L., McKean, H.E. and Newman, F.L. (1974). A personalized system of instruction in an undergraduate mathematics service sequence. *American Mathematics Monthly*, 81, 767-775.